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DISEASES AND INSECTS OF SMALL FRUITS

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DISEASES and INSECTS of SMALL FRUITS

P. H. Wooley and C. S. Koehler

The purpose of this bulletin is to give growers of strawberries, currants, gooseberries, and grapes information on the control of diseases and insects affecting these crops. To control insects and diseases efficiently it is necessary to know the life cycle of the various pests to allow control measures to be directed at the most vulnerable stage. Much of this material has been published elsewhere but is not readily available to growers. Additional information has been obtained from published and unpublished data of the research workers of the New York State Experiment Station.

Revisions of the insect and disease discussions are based on experimental work and data of the Geneva and Cornell Experiment Stations. Many valuable suggestions have also been received from the agricultural agents in those counties where growing small fruits is an important enterprise.

Diseases and insects only are covered in this bulletin. Information on varieties, types of plantings, fertilization, and other cultural practices related to strawberries is contained in Cornell Extension Bulletin 923, *Strawberry Growing* by M. B. Hoffman. Bulletin 719, *Raspberry Growing—Culture, Diseases and Insects* is also available from the Mailing Room, Stone Hall, Cornell University.

Most of the recommendations in this bulletin are on the basis of pounds of pesticide per 100 gallons. As a general rule, home fruit growers can obtain comparable rates by using one tablespoonful of pesticide in each gallon of water for each pound of material recommended per 100 gallons.

STRAWBERRIES

The most common diseases affecting strawberries are leaf spot, red stele root rot, black root rot, Verticillium wilt, and Botrytis fruit rot. During the past few years nematodes or "eel worms" have been found in many strawberry areas. Recent investigations in New York have shown nematodes to be a very important factor in strawberry production. In some locations the strawberry weevil has been a very serious pest. The strawberry leaf roller and strawberry rootworm are generally distributed throughout the state, and during 1956 the strawberry leaf roller caused considerable damage in many Hudson Valley plantings. White grubs are likely to be abundant periodically, especially in strawberry growing areas of Erie and Chautauqua counties. The tarnished plant bug and spittlebug can be found in most strawberry plantings in the state. Both of these insects reduce yields and deform the fruit, making it unattractive and unsaleable.

STRAWBERRY WEEVIL

(*Anthonomus signatus* Say)

The strawberry weevil has been serious chiefly in the Hudson Valley, but in recent years it has become a problem in some plantings in central and western New York. The insect is a small snout-beetle, almost black to reddish brown in color, and only about 1/10 inch long. It hibernates in the adult stage in rubbish, especially in woodlots or hedgerows adjoining strawberry fields, and there is evidence that some of the beetles may hibernate beneath the mulch in the strawberry patch. The beetles appear on the plants as soon as the blossom buds appear in spring. The beetle deposits an egg in an unopened bud and causes the bud to fall or hang suspended by cutting the pedicel. In this way the crop may be seriously reduced. Occasionally half or more of the buds may be destroyed. The young grub, strongly curved and of a white or yellowish color, hatches in about a week and at first feeds almost entirely on the pollen but later may attack other parts of the interior of the bud. The grub pupates within the bud and the beetle which emerges feeds for a short time on the pollen of flowers and then goes into hibernation in midsummer.

Control

Best control of the strawberry weevil is accomplished through the application of an arsenical, preferably in the form of an 80–20 hydrated-lime–lead-arsenate dust. Although less effective than a dust, a spray of 3 pounds of lead arsenate and 3 pounds of hydrated spray lime in 100 gallons of water may be used. Either a 3 to 5 percent DDT dust or 2 pounds of a 50 percent wettable DDT powder in 100 gallons of water may be used. Several applications at weekly intervals are needed, the exact number depending on the severity of the infestation. Generally, a minimum of two applications is required; the first of these to be applied when the weevils begin to cut the first blossom buds. In the Hudson Valley area this is usually early in May. A grower must be on the watch for the first signs of injury at this time and must make a close examination of the plants. Some growers prefer not to wait for the first signs of injury but to make the initial application when early blossom buds are forming. The application should be repeated.

After the first blossoms begin to form, lead arsenate or DDT should not be used because of the danger to bees and the possibility of excessive residues on early formed fruits. In heavy infestations where more than two early arsenical applications are needed, these should be followed by one or more applications of a pyrethrum dust containing 0.2 percent of pyrethrins until the beetles have ceased working.

Extreme thoroughness in applying the dust is necessary for satisfactory results. In commercial plantings usually the use of hand dusters is neither effective nor practical. A power duster with several outlets which hang close to the plants is the preferred type. Superior control has been obtained when the duster has a short apron attachment to confine the dust and to prevent loss of material from air currents. Since weevils are only active on warm days, it is advisable to apply dust, when possible, early on a warm, quiet day. About 30 to 50 pounds of dust should be applied per acre, the exact amount depending on the planting system.

It is not advisable to plant strawberries where the weevil is troublesome. This is next to woodlots, hedgerows, or overgrown fences, where the cover offers excel-

lent hibernating shelter for weevils and makes it more difficult to protect the crop from their attacks.

TWO-SPOTTED SPIDER MITE

(Tetranychus telarius (L.))

In some parts of the state, especially on Long Island, strawberries are subject to injury by heavy infestations of the common spider mite of the greenhouse. The spider mite is a small mite but considerably larger than the cyclamen mite. It varies in color from pale greenish yellow to dark crimson red, and is usually marked with two dark spots on the side of the body. The minute, pale eggs are on the underside of the leaves. Multiplication is rapid and, with favorable weather conditions, the mites often become so numerous as to seriously injure the plants before the crop is harvested.

Control

Two sprays, spaced 7 to 10 days apart, of one of the miticides listed below have given excellent control of two-spotted mites in New York State. To be effective, the materials should be applied to the undersides of the leaves.

TEPP (tetraethyl pyrophosphate).....Manufacturer's directions
or Kelthane.....1½ pounds
or Systox (demeton).....1½ pints per acre
or Malathion.....2 pounds

Systox should be applied any time before bloom or before the fruit sets to avoid excess residues. Both TEPP and Systox are extremely poisonous and should not be used unless all safety precautions listed on the label are followed. Kelthane has consistently given good control of mites in experimental tests and works well against resistant mites. Malathion may not perform well in commercial plantings and is suggested primarily for the home fruit grower. Both Kelthane and malathion are safe to use and require a minimum of safety precautions.

CYCLAMEN MITE

(Steneotarsonemus pallidus (Banks))

The cyclamen mite is a very small mite practically invisible to the naked eye. Adult females overwinter in the crevices between the bases of leaf stems. Females become active in early spring and begin to lay eggs from which tiny larvae hatch and begin feeding. The mites remain in unopened leaves in the plant crowns or between parts of leaves or flowers. This makes control measures exceedingly difficult. Heavy infestations of mites result in severe stunting and dwarfing of leaves. If not controlled mites may reduce the crop and in serious infestations may kill the plants outright.

Control

Cyclamen mites are most commonly introduced into a field through infested plants. Growers should insist on plants free of cyclamen mite when ordering them from a plant dealer. If mites become established in a planting they may be controlled by use of insecticide sprays. Thiodan, 1 quart of the 24 percent emulsifiable concentrate per 100 gallons water, is applied at a rate to give 400

gallons of spray per acre. Thiodan is not labelled for use after fruit buds appear in the spring. Endrin, 1 quart of 19.5 percent emulsifiable concentrate per 100 gallons of water, applied to non-bearing beds at the rate of 400 gallons per acre will also control cyclamen mites. The only material that can be applied to fruiting beds is Kelthane used at 1½ pounds per 100 gallons of water. All treatments should be applied to thoroughly wet the crowns of the plant. More than one application may be necessary to control cyclamen mites. In general, cyclamen mite infestations are in localized areas in the strawberry planting and only infested areas need to be treated.

STRAWBERRY LEAF ROLLER

(*Ancylis comptana fragariae* (W. & R.))

In the northern states and in Canada, strawberries are subject to injury from a small, greenish or brownish caterpillar which folds the two halves of the leaflet together and, feeding within the shelter so formed, causes them to turn brown and die. This insect can be found in many strawberry fields in New York, and during the 1956 season caused considerable damage to plantings in the lower Hudson Valley.

The insect hibernates both in the larval and pupal stages; the larvae in trash about the plants and the pupae in the folded leaves. The moths of the spring brood appear in May or early June and deposit their eggs on the strawberry leaves. The larvae, reddish brown to green in color, feed for a few days openly on the upper surface of the leaf and then draw the two halves of the leaflet together. In New York there are at least two broods annually.

Control

The most effective spray program is with TDE (DDD) in a single thorough spray, at the rate of 2 pounds of 50 percent powder in 100 gallons of water just before the blossoms open. TDE is a close relative of DDT. It is effective enough against tarnished plant bug so DDT is not needed for the plant bug where TDE is used.

Less effective control may be obtained by spraying plants twice with lead arsenate (3 pounds in 100 gallons of water), making the first application just before blossoms appear and the second after the crop has been harvested. This is to kill young larvae feeding openly on leaves before they are folded. The spray will not kill larvae in folded leaves.

STRAWBERRY ROOTWORM

(*Paria canella* Fabricius)

Beetles of the strawberry rootworm hibernate in trash on the ground about the plants. They emerge in early spring, and eat out holes in strawberry, red raspberry, and blackberry leaves. They are about ⅛ inch in length and black to reddish yellow in color. The eggs are deposited during May and June among fallen leaves on the ground. The grubs burrow through the ground feeding on the roots and become full-grown during July and August. They then transform to pupae and later to beetles in earthen cells in the ground. Most of the beetles emerge during August. After feeding for a time they hibernate.

Control

These insects are seldom a problem except in strawberry beds that are neglected or where a bed has been "left in" too long. By practicing the one-crop system of strawberry culture, the pest can be held to a minimum and serious damage prevented. Also, it is not advisable to make a new planting of berries next to an infested patch. Injury to leaves can be reduced by an arsenical spray, at the rate of 3 pounds of lead arsenate in 100 gallons of water, but this procedure is not considered practical unless a young productive bed becomes infested from unfavorable surroundings.

WHITE GRUBS

(*Phyllophaga* spp.)

The white grub, which is the larval form (figure 1) of the common brown June "bugs" (figure 2), is subterranean in nature, spending its life, during the growing season, burrowing through the soil in search of food. When the land is prepared for strawberries, all existing crops and crop remains are plowed under to destroy the food sources of white grubs. Strawberry plants set on this prepared ground are attacked by the grubs which sever the root from the crown an inch or two below the surface (figure 3).

With few known exceptions, the June "bugs" of this state require three years to complete their life cycle. Most of the time is spent in the grub stage in the soil, and it is during the second year, the year after the beetles fly, that grubs do practically all their damage. Based on records of past years it is possible to predict more or less accurately when years of severe grub damage will occur. The last two flight years, 1955 and 1958, were unfavorable for egg deposition and

PHOTOGRAPH FROM C. E. PALM

FIGURE 1. EARLY SECOND-YEAR WHITE GRUBS
About natural size

PHOTOGRAPH FROM C. E. PALM

FIGURE 2. ADULT JUNE BEETLE
Twice natural size

as a result damage was light in 1956 and 1959. The next predicted flight year is 1961 and damage can be expected in 1962.

Surveys have shown that grub-infested areas in New York are roughly concentrated in three sections, the Champlain Valley, the two southern tiers of counties, and the counties bordering Lake Ontario. Commercial plantings of strawberries are most likely to suffer important losses in Erie and Chautauqua Counties. The grubs like well-drained loamy soils and cannot survive in clays or in low wet areas. Thin stony soils are also favorable to the grubs.

Control

The beetles place their eggs largely in sod-covered land, and sod therefore is usually infested the year after a beetle flight. If infested sod is turned under and put into strawberries the year after a beetle flight, serious injury is likely to follow. In areas where grub damage has occurred, it is advisable to keep as much land as possible out of sod during years when beetle flights are expected.

White grubs may be controlled by treating the soil before planting when the second year grubs are numerous. Treatments are usually applied to the soil in the form of sprays and disced in immediately. The following insecticides are recommended for white grub control.

Chlordane.....10 pounds (actual) per acre
or Dieldrin.....5 pounds (actual) per acre
or* Lindane.....5 pounds (actual) per acre
or** Lead arsenate and sand.....1 pound and 20 pounds

*Lindane should not be used where root and tuber crops are rotated with strawberries.
**Lead arsenate-sand mixture is used at the rate of 1½ ounces per plant when setting plants out.

SPITTLEBUG

In some seasons spittlebugs, or "frog hoppers" as they are sometimes called, attract considerable attention and may cause important damage, although this point has not been thoroughly investigated. There is some damage in heavy infestations when a number of the insects gather on a single stem, flower, or leaf cluster. The fruit on these heavily infested plants is usually small and lacking in quality.

The young, immature insects are first observed in the spring, feeding within a frothy-like mass which increases in size as the hopper grows. It is these masses of froth that first attract the grower's attention.

Control

Control measures are seldom necessary except in heavy infestations. Healthy strawberry plantings are capable of sustaining moderate numbers of the hoppers without suffering important damage. In recent years most applications of insecticides have not proved practical.

A DDT spray containing 2 pounds of 50 percent wettable powder is effective in controlling spittle bugs. Lindane, 1½ pints of 20 percent emulsifiable concentrate per acre, or toxaphene, 1 quart of 60 percent emulsifiable concentrate per acre, applied when spittlebugs build up, has given control in experimental and commercial plantings.

PHOTOGRAPH FROM T. W. KERR, JR.

FIGURE 3. WHITE-GRUB INJURY TO ROOTS OF STRAWBERRY PLANTS

Top, injured roots; *bottom*, uninjured roots

The best control results when plants are treated during the first two weeks of May or about the time mulch is ordinarily removed from the beds.

TARNISHED PLANT BUG

(*Lygus lineolaris* (P. de B.))

In New York State strawberry yields may be substantially reduced as a result of tarnished plant bug activity. It is a brownish sucking bug about $^1/_5$ inch long (figure 4) when full grown and hibernates during the winter as an adult in trash, hedgerows, and other areas offering protection. It appears during late April or early May and is active on many fruits as well as weeds. The damage to

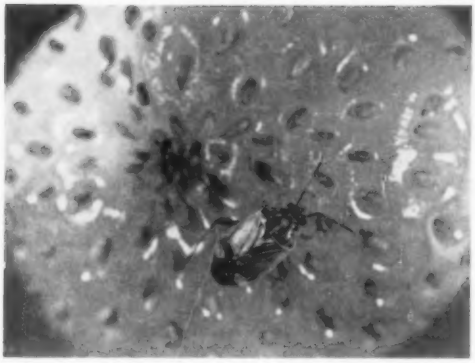


FIGURE 4. ADULT TARNISHED PLANT BUG ON STRAWBERRY

strawberries is a result of feeding punctures before the receptable or berry expands. The berries remain small and hard and turn dark in color. When the injury is only partial, the berries become deformed at one side or knobbed at the tip and are, therefore, low quality, unmarketable fruit.

Control

As plant bug infestations vary according to season and locality, all strawberry plantings will not benefit from treatments. There has, however, been enough damage to warrant insecticide sprays. Damage may be largely prevented by spraying with 2 pounds of 50 percent DDT powder just before the blossoms open. A 5 percent DDT dust may be used in place of the spray but with poorer control. The lindane or toxaphene, if used for spittlebug control, will also give some control of the tarnished plant bug.

CUTWORMS

In some seasons cutworms may cause considerable damage to newly set strawberry plants by cutting them off at or just below ground level. The cutworms work at night, and in the daytime usually hide under a clod of earth or stone, or about ½ inch below the ground level near plants that have been cut off recently.

Control

Chlordane or dieldrin applied in the form of granulated materials at a rate of ½ pound actual per acre have given good control of cutworms. Granulated materials should be applied in a broadcast application to be distributed evenly over the planting.

Cutworms may also be controlled in commercial and home plantings through the application of a poison bait. A moist, poison, bran mash is scattered or broadcast along rows of plants at sundown for cutworms to feed on at night. The formula for homemade bait is as follows:

Homemade bait

Materials	*Formula for 2 acres*	*Formula for ¼ acre*
Bran	20 pounds	2½ pounds
Paris green	1 pound	2 ounces
Molasses	2 quarts	1 cupful
Oranges or lemons	3 fruits	1 fruit
Water	3 to 3½ gallons	1½ to 2 quarts

Mix bran and paris green thoroughly. Add fruit juices to water. Dissolve molasses (cheap grade is satisfactory) in water. Pour molasses and water mixture over paris-green–bran mixture and stir to dampen the mash thoroughly. Include residue of fruit in a finely chopped condition in the bait.

The poison bait mixture is also effective when scattered a day or two before plants are set and after the soil has been conditioned for planting. By this practice cutworms are poisoned in advance of plant setting, and injury is often entirely prevented in infested plots.

STRAWBERRY ROOT WEEVILS

(*Brachyrhinus* spp.)

In New York several species of so-called root weevils attack roots or crowns of strawberry plants in the grub, or immature, stage. These are: strawberry root weevil, *Brachyrhinus ovatus* L.; black vine weevil, *B. sulcatus* F., rough strawberry root weevil, *B. rugosostriatus* Goeze, and alfalfa snout beetle, *B. ligustici* L. Of these species, the first three most commonly infest strawberry plantings. Damage is mostly to plantings in central and northern New York, but important losses are infrequent.

All species except the alfalfa snout beetle have a one-year life cycle, although some beetles are known to live at least two seasons. There is a slight variation in the life histories of the first three species, but for all practical purposes the three may be considered as one. Winter is passed in the ground as a larva or grub. In late spring these form oval earthen cells and change to an inactive, or pupal, stage. These pupae change to adults after several weeks, move to the surface of the ground, and emerge to feed on the plants at night.

Beds heavily infested with weevils show distinct patches or spots stunted in appearance, and the yield in these areas is materially reduced. Roots of injured plants are badly eaten away by grubs. Continued infestation may lead to complete destruction of the plants.

Control

Materials applied to the soil for control of white grubs should give adequate control of strawberry root weevils.

Where control measures have not been used for white grubs, strawberry root weevils may be controlled by use of a poison bait to kill adults after they come to the surface of the ground to feed on plant tops.

Although emergence of beetles may continue over a considerable period, for all practical purposes the best time to apply bait in most seasons in Up-State New York is during July. A good practical procedure is to apply the bait after the crop has been harvested. If a grower is planning to plow a patch, the treatment should be made first and sufficient time allowed for the bait to be taken by the beetles. If other beds are adjacent to the infested planting, it is wise to bait about a dozen rows of those next to the infested field.

A commercially prepared pre-mixed bait containing sodium fluosilicate as the killing agent gives satisfactory results. Growers should consult their county agricultural agents regarding a local source of supply. The bait recommended for control of cutworms (page 10) may also be used to kill strawberry root weevils. Baits should be applied at the rate of at least 30 pounds to an acre.

LEAF-SPOT

(Caused by *Mycosphaerella fragariae* (Tul.) Lindau)

All strawberry growers are familiar with the purple-bordered gray spots common on strawberry leaves. This disease is serious when spots are abundant and cause scorching of leaves or when fruit stems are attacked. Leaf-spot has been largely eliminated as a serious disease of strawberries through use of more resistant varieties. The Premier variety is outstanding for its freedom from injury by leaf-spot, particularly if the bed is fruited only one year.

Control

Strawberry leaf-spot is rarely important enough to justify control measures if it is the only disease present. Leaf-spot will be controlled by captan when used for control of Botrytis fruit rot. The incidence of leaf-spot may be reduced by locating the strawberry bed in an area which affords good air drainage and sunshine and which promotes rapid drying of the plants. Some benefits may be obtained by mowing and burning the foliage after picking the fruit.

BOTRYTIS FRUIT ROT

(*Botrytis cinerea Pers.*)

This disease is commonly known as "gray mold", "dry rot", or "brown rot". It is the most common and widely distributed fruit rot in New York State. Spread of Botrytis fruit rot in the planting is favored by abundant moisture from the bloom period through the harvest season. During 1958, prolonged rainy weather during this period caused losses up to 60 percent of the crop in the lower Hudson Valley.

Botrytis fruit rot is usually considered a disease that attacks the berries only, green or ripe. However, a blight often starts early in the season on blossoms and blossom clusters. Infections on blossoms usually extend down the pedicel and infect the calyx lobes. In certain instances, the disease may progress down the pedicel to the main fruit stem and prevent normal development of the fruiting cluster. During periods favorable for disease development, the infection spreads from the calyx lobes to the fruit. Infections may also arise on any part of the berry but usually start in the portion that touches the ground or another decayed berry. The first symptoms on the berries appear as light brown soft spots without definite margins. As the rot progresses the infected areas begin to dry and the berry becomes firm and tough. During wet periods the infected fruit becomes covered with a gray, dusty-appearing fungus growth. The spores in the fungus growth are easily detached and spread by air currents to other fruit to continue the disease cycle.

Control

Until recently, chemical control of this disease was not practical. In the past few years experimental data indicate that Botrytis fruit rot may be controlled by spraying with captan, 2 pounds per 100 gallons of water, at a rate of 300 gallons per acre. The first application should be applied immediately before bloom, followed by weekly applications through harvest. If the season is relatively dry, one or more of the applications may be omitted. However, more information is needed on the minimum number of applications necessary to

control Botrytis fruit rot. The sprays of captan as applied for control of this disease will also control leaf spot.

POWDERY MILDEW

(Caused by *Sphaerotheca macularis* (Wall R. ex-Fries) Cooke)

Powdery mildew is readily recognized by the upward curling of the leaf margins and the scorching of these leaves. Before the leaves curl a slight silvery appearance on the undersurface shows the presence of mildew fungus. Conditions favoring rapid growth of the plants in early spring or fall often result in outbreaks of mildew.

Control

Mildew is rarely serious enough to justify special control measures. Where this trouble has been serious in past years, partial control may be obtained by applications of 3–3–100 bordeaux mixture plus 1½ pounds of resin fish-oil soap. To be most effective these sprays should be started before any curling of the leaves. Sulfur dust is effective against mildew, but the danger of serious burning is so great that it cannot be safely used in this state.

VERTICILLIUM WILT

(Caused by *Verticillium albo-atrum* Reink & Berth.)

Verticillium fungus which causes wilt in black and red raspberries, has also caused many plantings of strawberries to wilt and die as the fruits start to ripen. Verticillium-infected strawberries show a darkening of the wood portion of the crown when cut longitudinally. Leaves of infected plants are pale and tend to curl. Reduced runner formation and later a reddening of petioles and stolons of both mother plants and runner plants are additional symptoms. Distinct symptoms do not usually appear until after blossoming, and wilt is more prevalent after the fruit begins to ripen.

Control

Strawberries should not be interplanted with, or follow tomatoes, potatoes, eggplants, peppers, or raspberries within three or four years. These crops are susceptible to the wilt disease and frequently infect the soil with wilt fungus. New plantings should be made only from stock that is healthy.

BLACK ROOT

(Caused by winter injury)

Many cases of stunting or death of strawberry plants are accompanied or preceded by more or less injury, or death of the roots. The most common type of injury is commonly called *black root* or *root rot*. While many different fungi have been isolated from these black roots and described as the cause of the root rot, none of them is ordinarily able to cause appreciable injury to roots of vigorous strawberry plants given good conditions for growth. Unquestionably, most of the black root and root rot of strawberries is initiated by winter injury. The core or stele of the roots is the last part to show discoloration, and injured

roots are frequently dark brown or black with a white stele. Internal discoloration of the crowns is also the result of winter injury. The control of black root thus consists in setting plants free from the injury and by mulching properly. Further information on mulching and on the purchase and handling of new plants may be obtained from Cornell Extension Bulletin 923, *Strawberry Growing*.

Recent investigations indicate that nematodes may also contribute to the amount of black root rot by injuring the roots and allowing soil fungi to enter. Experiments where nematodes have been controlled have shown a corresponding reduction in the amount of black root rot.

RED STELE

(Caused by *Phytophthora fragariae* Hickman)

A second root trouble of strawberries, called red stele, has appeared in many plantings throughout the state. The disease usually appears in the low parts of the planting in wet, poorly drained areas. Symptoms of the disease usually show early in the spring as the plants are emerging through the mulch. Diseased plants are stunted and the leaves remain small and cupped. The foliage of diseased plants has a lead blue-green cast as opposed to a normal green color. During the day, infected plants may wilt but usually recover in the presence of moisture. Infected plants rarely produce a normal crop of berries.

Positive diagnosis of red stele may be made by examining the root system of the plant. Infected roots lack the numerous fibrous roots of normal plants and have a "rat-tailed" appearance. By cutting lengthwise through the roots, the central core or stele will be red if the disease is present. No other disease of strawberries produces red discoloration in the stele of the root.

Control

The use of resistant varieties seems to be the only effective means of controlling this disease. Sparkle, Temple, Fairland, Pathfinder, and Stelemaster are some of the varieties resistant to the disease. During 1958 a few plantings of Sparkle showed evidence of red stele disease. This indicates that more than one form of the disease organism may be present in New York plantings.

YELLOWS

(Hereditary defect)

Considerable correspondence is received each spring from strawberry growers who are alarmed by the yellow leaves on some or many of their strawberry plants. The yellowing is unusually severe in cool springs, and the foliage becomes green during the summer. Federal plant pathologists who studied this trouble found it to be a hereditary defect rather than a virus. Yellows, also called *June Yellows*, is common in the Premier variety but also occurs in many other varieties.

Control

Since the defect is hereditary, plants that show yellows in the spring should be rogued or marked if new sets are to be taken from the bed.

NEMATODE DISEASES

Two species of nematodes, root knot nematode and root lesion nematode, cause most of the damage to strawberries in New York State. Of the two species, the root lesion nematode is most serious as it is almost universally present in all soils. With the possible exception of a few Long Island plantings, the root knot nematode has never attacked healthy strawberry plants.

ROOT KNOT NEMATODE

(*Meloidogyne hapla* Chitwood)

Root knot nematodes form swellings or galls on strawberry roots. Galls range in size from a fraction of an inch to ¼ inch in diameter. As a result of infection, the main roots show a reduction in growth and the formation of excessive branch roots above the galls. Infected plants may be stunted and weakened and when set out in the planting become sensitive to drought injury. Infected plants produce few runner plants resulting in a reduction in yield. Damage by root knot nematodes is usually more severe in light, sandy soils than in heavier soils.

Root knot may be prevented by planting stocks free of the disease. Growers should insist on nematode-free plants when ordering from nurseries. Most nurseries treat their propagation beds with soil fumigants to free plants of nematodes but absolute control is almost impossible. The need for soil fumigation in New York State for control of root knot has not been demonstrated except in a few Long Island plantings.

ROOT LESION NEMATODE

(*Pratylenchus spp.*)

Root lesion or meadow nematodes are present in most of the soils in the state. Recent investigations indicate that they may be responsible for some of the black root rot commonly found in strawberry plantings. The nematodes cause necrotic lesions in the cortex, or outer portion of the roots as a result of feeding or entering the roots. Soil fungi, normally considered as non-parasitic, enter the injured portion of the root to produce typical black root rot symptoms. In severe nematode infestations strawberry plants become stunted, less productive, and may be killed under conditions of severe drought. Soil fumigation may be of value in light, sandy soils where nematode populations are high.

Control

Where the need for nematode control has been demonstrated, the following soil fumigants are recommended:

Ethylene dibromide (83% by weight).....9 gallons/acre
or D–D Mixture.....25 gallons/acre

Before applying soil fumigants, growers should consult their county agent or state agricultural experiment station for additional information on methods of application, materials to use, and safety practices to follow. In general, the soil is plowed to a depth of 6–8 inches and disced thoroughly. Liquid fumigants are injected into the soil to a depth of 6–8 inches by special equipment. To be most effective the soil temperature should be between 50° and 60°F. at a depth of 6 inches. The soil moisture should approximate that recommended for good

seed-bed formation. Normally 3 weeks should elapse between fumigation and planting but the time interval will vary depending on the fumigant used. Growers are urged to follow the directions on the fumigant label to avoid plant injury. Because of the soil temperatures required for effective fumigation and the interval between fumigation and planting, fall fumigation is suggested for growers in New York State.

CURRANTS AND GOOSEBERRIES

Among insects attacking currants and gooseberries, the most troublesome are the aphis, the imported currant worm, the gooseberry fruitworm, and the San José scale. In recent years the imported currant borer has been troublesome in both eastern and western New York. The currant stem girdler is at present an important pest only on farms in the Chatauqua fruit belt. Leaf-spots are common on both currants and gooseberries.

Arsenical sprays or dusts cannot be used with safety on currants or gooseberries because of the dangers of objectionable spray residues. This danger may be prevented in currant or gooseberry plantings where these are the only crop; but where cherries, pears, and apples are interplanted, the residue problem is complicated. Washing methods that remove the residue have been developed, but these are not always satisfactory, particularly when the residues are heavy or if the fruit is washed after it has been put into storage and frozen.

It has been shown that all of the chewing insects affecting currants may be controlled with materials which do not leave objectionable residues. Therefore, if currants are grown by themselves or with other crops requiring no arsenical treatment, there will be no danger from these residues.

SAN JOSÉ SCALE

(*Aspidiotus perniciosus* Comstock)

Currants are especially subject to infestations of the San José scale. The scale is a waxy secretion covering the sac-like body of the insect beneath. The largest scales, about $^1/_{16}$ inch in diameter, cover the females, are gray, and nearly circular, with a central dark nipple surrounded by a yellowish ring. The smaller scales are nearly black with a central gray dot surrounded by a black depressed ring bordered by a grayish ring. In New York the females begin giving birth to living young during the latter part of June. Each female is capable of giving birth to nearly 600 young over a six weeks period. The young scales crawl around until a suitable place is found, insert their beak into the plant, and suck its juices. After molting a few times, winged males emerge and mate with the female. After a few more molts the insects overwinter as half-grown scales on the bark of the currant bush. In this stage they are most susceptible to control measures.

Control

A 2 percent lubricating oil emulsion spray applied at the dormant or green-tip stage in the spring before the buds burst gives excellent control. One of the dinitro compounds may be added to the oil to control the currant aphis as well as scale (page 17). Lime-sulfur (11 gallons in water to make 100 gallons of spray) may be used instead of the oil but is more expensive and not as satisfactory in heavy infestations.

Commercial or tank-mixed oil emulsions may be used. In the latter type the emulsion may be made in the spray tank, with blood albumin as the emulsifier. With the pump and the agitator running, enough water is placed in the spray tank so that the pump will work, and then ½ pound of the commercially prepared blood albumin (2 ounces actual blood albumin) is added. The correct amount of oil is added while the open spray gun is directed into the mixture in the tank. In a few minutes a creamy emulsion will be obtained. The tank should be filled with water and sprayed out, keeping the pump operating throughout the operation.

CURRANT APHID

(*Capitophorus ribis* Linnaeus)

The currant aphid passes the winter in the egg stage on twigs of the red currant, black currant, and gooseberry. It is an important pest only on the red currant and its varieties. Eggs hatch as buds are opening and the young lice find their way to the underside of the first leaves. Here they soon reach maturity and begin to give birth to living young. At first all lice are wingless, but, as the leaves become crowded, winged forms, which migrate to other leaves less heavily infested, are produced. Some individuals may go to other summer host plants but enough remain on the currant so that breeding is continuous throughout the season.

Currant leaves infested by lice become curled and distorted so that pocket-like cavities are formed on the underside where the aphids congregate. The upper side turns a bright red, variegated with yellow and green. Heavily infested plants may lose a large proportion of the leaves on the terminal shoot; the fruit does not ripen properly and may be stained by the honey dew secreted by the lice.

Control

Control of the currant aphid is best accomplished early in the season at the dormant or green-tip stage when the insects are in the egg stage and not moving about. The most effective materials for this purpose are the so-called dinitro compounds. These are available in a liquid, water-soluble form known as *Elgetol*, *Dinitrosol*, or *Krenite* and as a dry form, usually used with lubricating oil, and known as *dinitro* or *DN powder*. The liquid form is used at the rate of 1½ quarts in water to make 100 gallons. The powder is used at the rate of 1½ pounds in 100 gallons of water or 1 pound in a 2 percent lubricating-oil emulsion spray such as is employed in the control of San José scale (page 16). If the liquid form is combined with the oil, the concentration is cut to 1 quart. When the liquid form is combined with the oil, the blood albumin emulsifier used in preparing a tank-mixed emulsion is reduced to ¼ pound of the commercial product (1 ounce of actual blood albumin). The oil-nitro compounds are applied at the dormant stage.

The currant aphid may also be controlled by spraying with 1 pint of nicotine sulfate and 2 to 3 pounds of soap flakes in 100 gallons of water when the first leaves have a diameter of from ½ to 1 inch. The material must be applied to hit the aphids on the underside of the leaves.

If an early application is made with care and thoroughness, it may not be necessary to spray again during the season. If, however, the infestation is severe, additional applications of the nicotine formula may be necessary when the insect

threatens to be destructive. These treatments are likely to become necessary just before blossoming and about a month before picking.

The effectiveness of the treatments may be greatly increased by pruning to reduce the number of canes, thus keeping the bush open instead of compact, and by removing all canes lying on or near the ground.

IMPORTED CURRANTWORM

(*Nematus ribesii* (Scopoli))

The adult of the currantworm is a small sawfly, about 1/8 inch long, with head and thorax more or less black and a yellowish abdomen. The eggs are deposited in rows along the principal veins on the underside of the leaves. The eggs of the first brood are laid soon after the leaves have expanded; those of the second brood in late June or early July. The small whitish larvae begin their destructive work by eating small holes through the leaves. As the larvae increase in size the color changes to green and soon the body becomes covered with many black spots, and the head is black. While small, the worms feed in colonies of 30 or more on a leaf, but they soon scatter to other parts of the plant. When numerous, they are able to strip a bush of its leaves in a few days.

Control

It is unsafe to spray or dust currants with an arsenical because of the residue left on the fruit and fruit stems. Excellent control of the currantworm has been obtained by spraying or dusting with rotenone-bearing compounds. As a spray, ground derris or cubé powder, containing from 4 to 5 percent rotenone, is used at the rate of 2½ to 3 pounds in 100 gallons of water. This material may be combined with bordeaux mixture or other copper compounds employed in disease control. If these are not being used, from ½ to 1 pound of powdered skimmilk or soybean flour should be added to the derris or cubé powder as a spreader. A 1 percent rotenone dust may be used instead of the spray. When dusts are used, a second application should be made from 5 to 7 days later. Sprays or dusts should be applied as soon as the worms hatch and are observed feeding on the leaves.

The same rotenone applications made for gooseberry fruitworm will also hold the currantworm under control. In some seasons, however, it is necessary to afford protection against the currantworm sooner than applications are needed for the gooseberry fruitworm.

Pyrethrum, either as a spray or dust, is also effective against the currantworm. As a spray, 3 pounds of pyrethrum is used in 100 gallons of water, and as a dust, a mixture containing 0.2 percent of pyrethrins is used. Proprietary pyrethrum extracts used at the manufacturers' directions are likewise effective. In addition, the bordeaux mixture used for disease control itself will be successful against worms that are not more than three-fourths grown.

GOOSEBERRY FRUITWORM

(*Zophodia convolutella* Hbn.)

In recent years the gooseberry fruitworm has caused considerable damage in certain gooseberry and currant plantings in the Hudson Valley. The insect hibernates in the pupal stage in debris at the base of bushes or beneath near-by

stones and clumps of earth. The moths appear in the field during the last ten days in April and in early May. The adult females deposit their eggs in open blossoms of both gooseberries and currants. The young larvae enter the developing berries and destroy the pulp. As the larvae grow they desert the first berries attacked and construct nests by tying together, with delicate silken threads, several berry clusters and adjacent leaves of the currant and the gooseberry. The caterpillars feed on the berries until they are full grown. The full grown larvae are about ¾ inch long, and greenish in color, with a brown head. About the middle of June the worms drop to the ground where they immediately seek shelter and pupate. There is only one brood annually.

Control

The gooseberry fruitworm may be effectively controlled with thorough, timely applications of rotenone sprays or dusts. For light to moderate infestations, one spray containing 3 pounds of powdered derris or cubé root (from 4 to 5 percent rotenone) and from ½ to 1 pound of soybean flour or skimmilk powder in 100 gallons of water should be sufficient. The derris or cubé powder may be used with bordeaux mixture or other copper compounds used to control diseases. Spray should be applied soon after the berries turn red and some webbing is apparent, which in the Hudson Valley is usually from the middle to the end of May. Close examination of light colored berries often reveals worms inside. If rains follow soon after the treatment, or infestations are heavy, a second application may be necessary about 7 days after the first application. If dusts are used, treatments should be made at about the same time as for sprays. A 1 percent rotenone dust made with a good grade of dusting sulfur, talc, or clay is suggested. When dusts are used, an extra application is necessary. It is unsafe to spray or dust currants or gooseberries with an arsenical because of the danger of objectionable residues.

CURRANT STEM GIRDLER

(*Janus integer* Norton)

The currant stem girdler has been injurious in practically all plantings in the Chautauqua fruit belt and in some of the plantings in the Hudson Valley. The adult is a sawfly about ½ inch long; the body is black, the legs brownish yellow, the abdomen yellowish. Adults appear the latter part of May. The female punctures one of the new canes a few inches from the tip and deposits an egg in the pith. She then girdles the cane about an inch above the egg, causing the tip to die and fall off (figure 5). On hatching, the grub burrows downward in the pith for about 6 inches before maturing. It then forms a cocoon in the burrow, where it passes the winter as a larva. It pupates in the spring and the adults emerge in May. There is only one generation a year.

Control

Bordeaux mixture, 2–10–100, plus 1 pint of nicotine sulfate is the most promising spray in the investigations in the Chautauqua-Erie belt where damage from the insect is most acute. In the Hudson Valley, where the girdler is less of a problem, reasonably good control has been accomplished by cutting off and destroying the infested canes. If this operation is performed in May, only 2 or 3 inches of the infested tips need be removed. Later, after the larvae have worked down in the tips, it is necessary to remove from 6 to 8 inches. In the

FIGURE 5. DAMAGE CAUSED BY THE CURRANT STEM GIRDLER

Left: uninjured cane; *center:* injured cane showing wilted tip before falling; *right:* injured cane from which the tip has fallen

Chautauqua-Erie area, tip removal has not proved successful, largely because many of the infested tips are missed in the removal operation. Going over the field several times has helped somewhat in correcting this situation. In some seasons the insects are greatly reduced by their natural enemies, but they are soon likely to build up again to serious proportions.

CURRANT BORER

(Ramosia tipuliformis Clerck)

The currant borer has increased in abundance in both the Chautauqua and Hudson Valley fruit belts. The adult is a clear-winged moth with a black body. The male has four yellow bands on the abdomen and the female has three. Adults appear in late May and early June. Eggs are deposited singly in cracks and crevices in the bark of wood which is one or more years old. In severely infested plantings, eggs are deposited on shoots produced during the current season. After hatching, the grub or young borer burrows into the pith and feeds either upward or downward for a distance of from 3 to 5 inches. As a result of this injury the shoots lose vigor, also some of the shoots die in the spring soon after the period of fruit set.

Control

During the past several seasons, parathion has given control of the borer populations. One application of 1.5 pounds of the 15 percent parathion wettable powder proved to be about as efficient as two treatments. The application should be made about 12 days after the first moth emerges. The spray should be applied at the rate of 350 gallons an acre. A hooded grape-spray boom is a satisfactory machine that has been used in the Chautauqua-Erie region. Parathion should not be used by home gardeners nor should it be used by commercial growers unwilling to follow the instructions regarding its safe use. As experience with this method of control is limited, the assistance of the local county agricultural agent should be obtained in timing the spray.

For home gardens, the most practical method of control is to remove infested canes. Malathion, 2 pounds of the 25 percent wettable powder, may give suitable control for the home fruit grower if the application is properly timed.

LEAF-SPOTS

(Caused by *Mycosphaerella grosulariae* (Fr.) Lindau, and *Pseudopeziza ribis* Klebahn)

Mycosphaerella and Pseudopeziza leaf-spots are common in this state and often cause defoliation of currants and gooseberries. The Mycosphaerella leaf spot is more important on gooseberries, while the Pseudopeziza leaf spot is more serious on currants. Defoliation caused by these diseases is more serious if it occurs before the crop is ripe.

While *Pseudopeziza ribis* is primarily a leaf trouble, occasionally it becomes serious on fruits and is known as *anthracnose*.

Control

Although leaf-spots may cause considerable loss, local experience will determine whether spraying for their control is necessary. When it is advisable to spray for leaf-spot, two applications of the fungicide are used: the first immediately after bloom and the second from 2 to 3 weeks later. The best control of the leaf-spots is obtained by the use of 3–3–100 bordeaux mixture or with 2 pounds of zineb (zinc dimethyldithiocarbamate) plus sticker in 100 gallons of spray. For gooseberries, the lime in the bordeaux mixture is increased to 5 pounds per 100 gallons of spray to reduce copper injury. The copper injury may be prevented by the use of ferbam or captan at the rate of 2 pounds to 100 gallons of spray. Ferbam or captan give commercial control of the leaf-spots and excellent control of Botrytis mold-rot as well. A spray of 3–3–100 bordeaux mixture or of zineb 2–100 after harvest provides additional control of leaf-spots and is advisable in years favorable to their development.

BOTRYTIS MOLD ROT

(Caused by *Botrytis cinerea* Pers.)

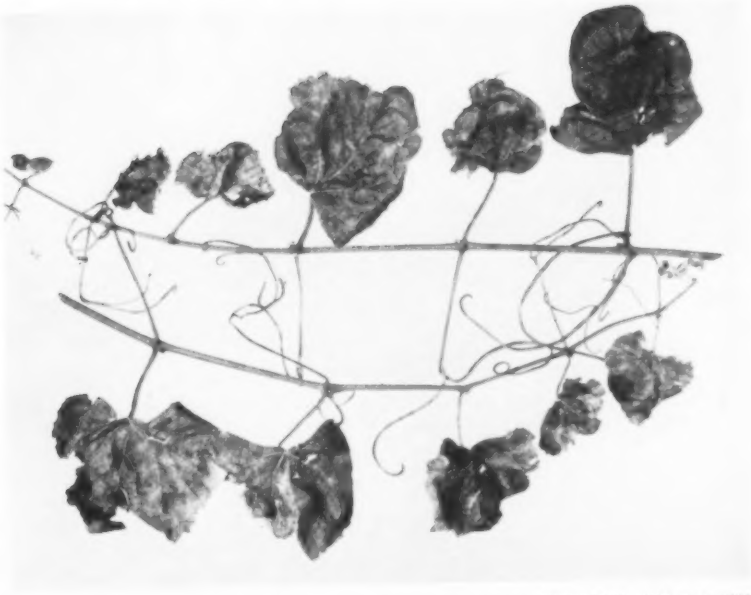
Botrytis mold rot may cause serious losses to currants when cool, wet weather prevails during bloom. Losses are more severe when the bushes have been allowed to become thick.

Control

Sprays of either ferbam or captan at the rate of 2 pounds per 100 gallons should be applied, just before bloom, just after bloom, and 2 weeks later. Both materials are effective against Botrytis mold-rot, and frequently their use is followed by higher yields and better growth than with the use of bordeaux mixture. The ferbam or captan schedules usually control leaf-spot as well.

GRAPES

The principal diseases affecting grapes in New York are dead arm, black rot, and powdery and downy mildew. Black rot is rather general throughout the state. Powdery mildew is common in western New York and may appear in other areas, while downy mildew is prevalent only in the Finger Lakes Region. Dead



PHOTOGRAPH FROM R. E. SUTT

FIGURE 6. POWDERY MILDEW ON LEAVES

PHOTOGRAPH FROM R. E. SUTT

FIGURE 7. POWDERY MILDEW ON FRUIT CLUSTER

arm has appeared in all areas of the state but is most serious in the Hudson Valley and Finger Lakes area.

The grape leafhopper is widely distributed throughout the state. The berrymoth has been most troublesome in the Lake Erie Region. The rose chafer is destructive only in sandy regions.

POWDERY MILDEW

(Caused by *Uncinula necator* (Schw.) Burr.)

Powdery mildew is often destructive in the western New York grape belt and is occasionally serious in other parts of the state. The first spots of mildew appear on green parts of the vine in early or mid-July. Soon some leaves are covered with fungus, which then attacks fruit clusters, spreading rapidly on the stalks and berry stems.

By harvest these stems are withered and brown, the berries are dwarfed, and many of them covered with a thin white film of mildew. Probably the most serious loss is caused by the shelling of the berries on affected clusters both in the vineyard and in transportation.

Control

Fixed copper used at a rate to give 1 pound of actual copper plus 4 pounds of hydrated spray lime in 100 gallons of spray is preferred over bordeaux mixture where copper injury is a problem. Bordeaux mixture 2–4–100 is effective against powdery mildew but may reduce vine growth and yield. Either fixed copper or bordeaux mixture should be applied from 7 to 10 days after bloom to control mildew. A second spray from 17 to 20 days after bloom is needed only where fixed copper or bordeaux mixture was not applied before and after bloom and from 7 to 10 days after bloom.

DOWNY MILDEW

(Caused by *Plasmopara viticola* (B. and C.) Berl. and de Toni)

Downy mildew is largely limited to the Finger Lakes Region of central New York and particularly to the Keuka Lake area. Occasionally a small

PHOTOGRAPH FROM R. F. SUIT

FIGURE 8. DOWNY MILDEW ON GRAPE CLUSTERS

FIGURE 9. DOWNY MILDEW ON LEAF

amount appears on susceptible varieties in other parts of the state. Attacks may occur at any time from the blooming period until the grapes are picked. The first signs of the disease are small greenish-yellow indefinite spots on the upper surface of the leaves. These spots gradually become brown, dry, and brittle. On the lower surface of the leaves similar spots which are soon covered with a downy white growth appear. The affected berries become hardened and grayish blue in color. Later the berries turn a livid brown or red and finally shrivel into mummies. Badly diseased fruits shell easily.

Control

Sprays of fixed copper at a rate to give 1 pound of metallic copper in 100 gallons of spray or captan at 2 pounds per 100 gallons of spray are preferred over 4–4–100 bordeaux mixture where copper injury is a problem. Three sprays should be applied: just before bloom, just after bloom, and from 7 to 10 days later. The Bordeaux mixture is most effective in downy mildew control but causes moderate to severe spray injury especially in low-vigor vineyards. An additional spray 2 to 3 weeks later may be needed in seasons favorable to downy mildew.

BLACK ROT

(Caused by *Guignardia Bidwellii* (E.) Viala and Ravaz)

Black rot first appears on fruit, when the berries are about half-grown, as a light area surrounded by a brownish line. The spot enlarges rapidly and becomes sunken and covered with many fine dark specks. The entire berry is soon involved and becomes a hard and shriveled mummy. Although the berries are most seriously affected, the disease often appears first on the leaves in June or July in the form of reddish-brown rather circular spots. The centers of these spots soon turn gray and are studded with many fine black specks, the fruiting bodies of the fungus. All green parts of the vine may be attacked.

FIGURE 10. BLACK ROT ON FRUIT

Control

Ferbam, 1½ pounds, or captan, 2 pounds, in 100 gallons of water are the most effective fungicides for black rot control. Ferbam is not as effective as the copper fungicides or captan in the control of downy mildew. On the Concord variety, which is resistant to downy mildew, ferbam or captan are the preferred fungicides.

On the Catawba, Niagara, and Fredonia varieties, which are susceptible to downy mildew, a 4–4–100 bordeaux mixture plus 1 pound of resin fish oil soap or some other good wetter-sticker is the most effective spray for combined control of black rot, downy mildew, and powdery mildew. Fixed copper at a rate to give 1 pound of metallic copper plus 4 pounds hydrated lime in 100 gallons of spray is also preferable to ferbam on these mildew-susceptible varieties. Captan at 2 pounds in 100 gallons of spray will give combined control of black rot, downy mildew, and dead arm.

PHOTOGRAPH FROM R. F. SUIT

FIGURE 11. BLACK ROT ON LEAF

For black rot control with any of these materials, three sprays should be applied: just before bloom, just after bloom, and from 7 to 10 days later. Where powdery mildew is a problem, the fixed copper or bordeaux mixture should be

substituted for ferbam in the spray 7 to 10 days after bloom. In some seasons, a fourth spray may be required 3 to 4 weeks after bloom for black rot control. Resin fish oil soap should not be used with ferbam or captan.

Proper timing of the sprays is important in controlling black rot. The after-bloom spray should be applied *immediately* after bloom, not several days later. The next spray should be applied from 7 to 10 days later rather than 2 weeks as suggested some years ago.

Thorough as well as timely sprays are required for good control of black rot. For the average vineyard, 150 gallons to an acre are needed in the pre-blossom sprays and from 200 to 250 gallons in the post-bloom sprays. In vineyards that have been severely infected with black rot, increasing the ferbam to 2 pounds in 100 gallons of spray may be justified. The bordeaux mixture may also be raised to an 8–8–100 formula, but this strength increases the danger of serious copper injury.

DEAD ARM

(*Cryptosporella viticola* Shear)

Dead arm of grapes has occurred in all the grape-growing regions of New York State. Although losses caused by this disease are not as spectacular as those caused by other diseases, they do amount to a considerable sum over a period of years. Dead arm disease is caused by a fungus which attacks the leaves, shoots, main branches, and trunks of the vine. The fungus gains entrance into the plant through wounds, winter injury, or by direct penetration of woody tissue. After gaining entrance into the plant, the fungus lives as a perennial parasite in the woody tissue. Infected areas are killed and cankers are produced as the fungus invades new tissues. When it reaches the trunk girdling of the arm or trunk may occur.

On affected arms of the vine where partial girdling has taken place the buds may fail to develop normally and shoot growth is weak and retarded. When shoots finally develop they are stunted, internodes are shortened, and leaves on the shoots are small, cupped, yellowish, and have crinkled margins. These symptoms are present in late May and June and are positive means of identifying this disease. Later in the season the leaves may drop and secondary leaves develop which have a normal appearance. However, once affected the plant never recovers and the entire arm will be killed. If not controlled, the infection may spread down the trunk and kill the entire vine.

Control

In the spring fruiting bodies in the canker produce spores capable of starting new infections. Current season infections may be controlled by spraying with captan, 4 pounds in 100 gallons of water, at the rate of 50 gallons of spray per acre when the new shoots are 1–2 inches long and again when the shoots are 4–6 inches long. The most effective measure for eradicating dead arm from the vineyard has been the removal of infected arms or vines. Infected portions of the vines should be removed well below the margins of the canker. If the trunk is seriously infected it should be severely pruned and a renewal shoot started. Pruning infected vines is best accomplished when the foliage symptoms are most pronounced.

ROSE CHAFER

(*Macrodactylus subspinosus* Fabricius)

The rose chafer is an ungainly, long-legged, grayish-brown beetle about ½ inch long. The beetles invade the vineyards, often in swarms, about the middle of June or about the time grapes are ready to blossom. They feed on the blossom buds or blossoms and later attack the newly set fruit and the foliage. The beetles remain in the vineyard for ten days or two weeks and then migrate to other plants then in blossom.

Control

Fortunately, rose chafers are numerous only in sandy regions. The larva of the chafer is a grub that feeds on the roots of grasses in sandy soil. The female beetle will not enter heavier soil for egg laying nor do the grubs thrive under such conditions. Vineyards on sandy soil should be kept free of grass. If a grass-sod has been allowed to develop under the rows and the roots are infested with larvae, it should be cleaned out in the spring and the ground thoroughly cultivated in May and the first half of June to destroy as many as possible of the insects in the pupal stage. It is also well to keep as much as possible of the surrounding land in cultivated crops and to reduce to a minimum the area of waste grassland near the vineyard.

The most effective method to control rose chafer is to spray the vines thoroughly, when the beetles first appear, with the following formula:

DDT (50 percent wettable powder) ..... 2 pounds
Water to make ..... 100 gallons

If necessary, a second application of DDT may be made from 10 to 14 days later.

GRAPE FLEA BEETLE

(*Altica chalybea* Illiger)

Just as the grape buds are ready to burst in the spring they are subject to attack by a small, glossy, greenish, or steel-blue beetle a little less than $^1/_5$ inch long. It eats out the contents of the bud and thus destroys the future cane. Each beetle usually devours several buds. If the beetles are at all numerous, the size of the crop may be seriously reduced. The beetles deposit their eggs under strips of loose bark on old canes and the brownish, black-spotted grubs may be found during June and the first half of July feeding openly on the upper surface of leaves. Pupation takes place in the ground. The beetles hibernate under fallen leaves and other rubbish in waste fields and in nearby woodlots. The part of the vineyard lying next to such waste land is most subject to injury. This is especially true if wild grape vines are allowed to grow there. The insects breed undisturbed on the wild vines and the following spring the beetles move into the vineyard.

Control

Wild grapevines should not be allowed to grow in the immediate vicinity of a vineyard. A thorough eradication of such breeding centers often solves the problem and renders other control measures unnecessary.

In the past, chemical control measures for this insect have been unsatisfactory. Experimental evidence, however, obtained during the spring of 1947, shows the

beetles to be very susceptible to DDT when 2 pounds of a 50 percent wettable powder is used in 100 gallons of water. In vineyards where this pest is a problem, DDT is suggested for trial. It should be applied in the spring as soon as the beetles appear on the vines. One application should be enough but, if necessary, a second application is suggested from 10 to 14 days after the first.

If the beetles are found on the vines in the spring and the trial of DDT does not seem desirable, handpicking is the only other method that will prevent destruction of the buds. Beetles may be jarred into a pan containing a little kerosene oil. The beetles must be collected when they are most active, in the warmer part of bright sunny days, for in cold weather it is hard to find them. When alarmed the beetles feign death and drop at the slightest jar. Shaking the vines or jarring the trellis will cause them to fall, for some distance along the row. It is most satisfactory to use a small stick about the size of a lead pencil to dislodge the beetles and to make them fall into the pan of oil held beneath.

GRAPE LEAFHOPPER

(*Erythroneura comes* Say)

The grape leafhopper is present in most vineyards of the state and, although its abundance varies from season to season, most growers now recognize that annual protection from this insect is worth while. It is not possible to anticipate at the time insecticidal treatments need to be applied how extensive the damage to the crop at harvesttime may be; thus hopper control may be considered a kind of insurance.

The adult hopper is scarcely $\frac{1}{8}$ inch long, pale in color, with back and wings marked with yellow and red. The insect hibernates as an adult in the fallen leaves in woodlots and thick grass in waste fields, along fences, hedgerows, and in swales and hollows. They emerge from hibernation about the first of May and feed on a large variety of plants, often extensively on bush fruits, until the grape leaves are well expanded. Then they migrate to the vineyard. Here they feed almost exclusively on the underside of the leaves. Egg laying begins about the first of June and continues for about a month. The eggs are inserted just beneath the lower epidermis of the leaf and are very difficult to see even with a lens. Hatching begins in late June and is usually practically complete by the middle of July, but the exact time varies with the season. The nymphs require about a month to reach maturity and, like the adults, feed on the under side of leaves. A complete or partial second brood develops. These can cause serious damage in some seasons if protective treatments are not made for the first brood. The greatest injury to vines comes from the adults and nymphs feeding during August and September. The adults swarm over the vines, sucking the life from the leaves and smutting the fruit with their excrement. The injury to the foliage prevents the proper ripening of the fruit, which in consequence never acquires desirable color, flavor, or sweetness. An even more important consideration is the reduction in crop yield which in some seasons may represent the difference between profit and loss. Leafhopper damage may greatly reduce the vitality of vines and their ability to produce profitable crops in future years.

Control

The grape leafhopper is best controlled by the application of a spray containing DDT. Since the hoppers are found largely on the underside of the leaves,

it is important that the spray be directed upward to hit those areas. This can be best accomplished by a special type of hooded boom or a homemade attachment constructed to enclose the rows and confine the spray, thus preventing loss and insufficient coverage from winds and air currents. Specifications and illustrations of a homemade hooded boom may be obtained from the New York Agricultural Experiment Station at Geneva.

The single application may be applied immediately before bloom or 10 to 14 days after bloom. A special application for leafhopper should not be necessary if DDT is used for the control of grape berry moth as suggested in this bulletin.

For the application when most of the eggs have hatched, the following schedule is suggested:

DDT (50 percent wettable powder)	1 pound
Water to make	100 gallons

This formula may be used with bordeaux mixture, ferbam or captan, if needed at the time for disease control. From 175 to 200 gallons of the spray should be applied to an acre to obtain maximum protection from hoppers.

GRAPE BERRY MOTH

(*Paralobesia viteana* Clemens)

Although the grape berry moth is present in small numbers in most vineyards of the state each year, destructive outbreaks have been only in the Chautauqua area. In some instances the infestation seems to be general throughout the region, but more often it is more or less sporadic, being confined to certain vineyards or parts of vineyards. Before 1937 outbreaks of the berry moth were of brief duration, reaching a peak and then dropping off sharply, all within a period of a few seasons. Since that time heavy infestations have persisted every year and the insect has spread extensively, damaging many vineyards not previously infested. Infestations have usually been heavier in vineyards near Lake Erie than on the gravelly ridges farther inland.

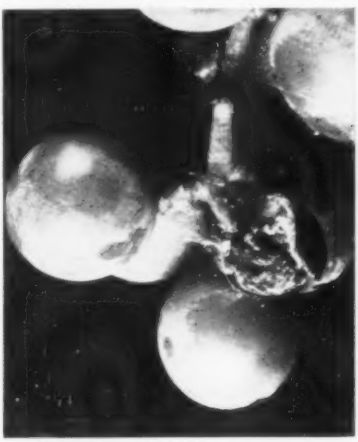


FIGURE 12. DAMAGE CAUSED BY FIRST BROOD OF GRAPE BERRY MOTH LARVAE

Variations in infestations between localities and between sections of the same vineyards may be due to the amount of snow cover on the ground during the winter. Natural or artificial windbreaks cause an accumulation of snow which may provide greater protection for the pupae of the berry moth that winters on the surface of the ground.

The grape berry moth passes the winter in the pupal state in its cocoon. The larva forms its cocoon by cutting out a small piece of the leaf and folding it over to form a cavity which it lines with silk. The cocoon is connected to the leaf at each end by a

small, uncut piece of leaf tissue. The cocoons of the first brood are all made in green leaves on the vine and usually remain in place until the moth emerges. Many of the second-brood larvae, however, do not form cocoons on leaves on the vine but descend by a silken thread to the ground. Here they usually make their structures on sodden or decaying leaves which are anchored beneath the trellis by small amounts of soil. Generally the leaves which are blown about by the wind contain few cocoons. The pupae in these cocoons are killed by temperatures below 10° F. If the ground remains covered by snow during the winter, the pupae are protected from the cold and an abundance of moths are likely to emerge the following spring. The insect is more likely to survive in parts of the vineyard where snow drifts form in hollows or in the lee of hedges, fences, and other obstructions.

The small, purplish-brown moths emerge from the overwintering cocoons from early June to mid-July; the peak of emergence is usually about blossoming time or shortly thereafter. They deposit their thin, rounded, scale-like eggs on the stems of the blossom clusters and later on the young grapes. Some of the larvae hatching from these earlier deposited eggs make a slight web among the blossom buds and feed on the buds, blossoms, and newly set grapes. This early activity, however, is relatively unimportant in most vineyards. The later-appearing first-brood larvae enter the grapes when the berries are the size of peas or larger and cause conspicuous, red discolorations and splitting on the green grapes. When full grown, the larvae are about $\frac{3}{8}$ inch long and vary in color from dark greenish to purplish, with a dark-brown head. At this time they desert the berries, crawl to the leaves, and pupate in the manner previously described. These pupae change to moths which lay eggs on the berries or stems during late July, during August, and even in September in some seasons. The larvae hatching from these eggs enter the fruit and cause the familiar so-called "wormy grapes." A "worm" caterpillar will leave one berry, enter others, and web them together. As many as four or five berries may be damaged by a single larva. This damage is noticeable at harvesttime; in vineyards where the pest is not controlled, it becomes necessary to remove by hand the injured fruits, a costly, time- and labor-consuming operation. Finally, pupation of these second brood "worms" takes place as previously described, either on leaves attached to the vines or on those on the ground beneath.

Control

By following a satisfactory spray program and using efficient equipment, adequate control of the berry moth may be accomplished in most vineyards. In heavy infestations, however, it is advisable to supplement the spray program with certain cultural practices.

Control by spraying. The larvae of the berry moth may best be killed by the application of DDT during the periods when they are most active. To properly control the grape berry moth, adequate spraying equipment is needed. This should consist of a sprayer with a minimum pump capacity of 15 gallons a minute at a pressure of 400 pounds. The boom should consist of two units, one of which delivers spray to the inner side and the other to the outer side of the same row. Each consists of two vertical rows of nozzles. The boom is covered with a hood which envelops the vines. It is essential that the vines, and especially the fruit clusters be thoroughly covered with spray. From 200 to 225 gallons of

spray should be applied to the acre. Usually two applications are made for the first brood and one for the second brood. The following schedule is suggested for berry moth control in the Chautauqua belt.

First Brood

First berry moth spray (just after the fruit has set)

Fungicide	Recommended rate
DDT (50 percent)	2 pounds
Miscible oil[1]	½ pint

Second berry moth spray (10 days after first spray)

Fungicide	Recommended rate
DDT (50 percent)	2 pounds
Miscible oil	1 quart

[1] 1 part Triton B1956, 9 parts oil

Second Brood

Third berry moth spray (late July or early August)

Fungicide	Recommended rate
plus Parathion (15 percent)	1½ pounds
or Methoxychlor (50 percent)	2 pounds
or Diazinon (25 percent)	2 pounds
plus Water to make	100 gallons

Three sprays of DDT with the oil-type spreader sticker will result in excess residues at harvesttime. To reduce residues one of the insecticides listed above should be substituted for DDT. Safety precautions should be followed when using parathion and diazinon. Home fruit growers should use methoxychlor in the third spray.

Cultural control. While spraying offers the most practical program for the control of berry moth, in heavy infestations certain cultural practices may be necessary as a supplementary measure.

Various experiments have shown that if the cocoons are kept covered with at least ½ inch of soil during June and July, most of the moths that emerge will be abnormal and thus unable to propagate the species. The practical difficulty is to cover thoroughly and to keep all cocoons covered. To assure proper vine growth, the centers must be cultivated during May, June, and a part of July. This cultivation uncovers some cocoons. The only practical use of this method of control is to cover the trellis strip (a strip about 18 inches wide directly beneath the vines), and to keep it compacted and covered during June and part of July. No horse-hoeing should be done until July 10 or 15 if the grape berry moth is to be controlled by a soil cover. If this practice interferes with the best cultural program for keeping vines vigorous, the grower will have to rely on an intensified spray program.

GRAPEVINE TOMATO GALL

(*Janetiella brevicauda* Felt)

Since 1948 the grapevine tomato-gall has been observed in grape plantings in all areas of the state but is most serious in the Hudson Valley. The galls

occur on the leaves, petioles, tendrils, panicles, and stems of the grape vine. The color of the gall varies from deep red, through reddish-yellow to green. The galls are divided into compartments in which orange-yellow grubs or larvae may be found. The larvae drop to the ground, pupate, and later small flies emerge and deposit eggs on the growing shoots. Normally there are three generations per year, but control measures are directed against the larvae of the spring generation.

Control

One spray of parathion, 1½ pounds per 100 gallons, applied when the first swellings appear has given commercial control of the grapevine tomato gall. This spray kills the majority of the larvae on the plant before they can penetrate the host tissues. In the Hudson Valley the spray is normally applied about May 15 but timing may vary according to the season. Home fruit growers should avoid the use of parathion. Two sprays of malathion, 2 pounds per 100 gallons, are suggested, the first spray about May 5 and the second about May 15. Malathion has not been tested in commercial plantings.

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